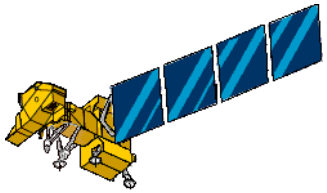
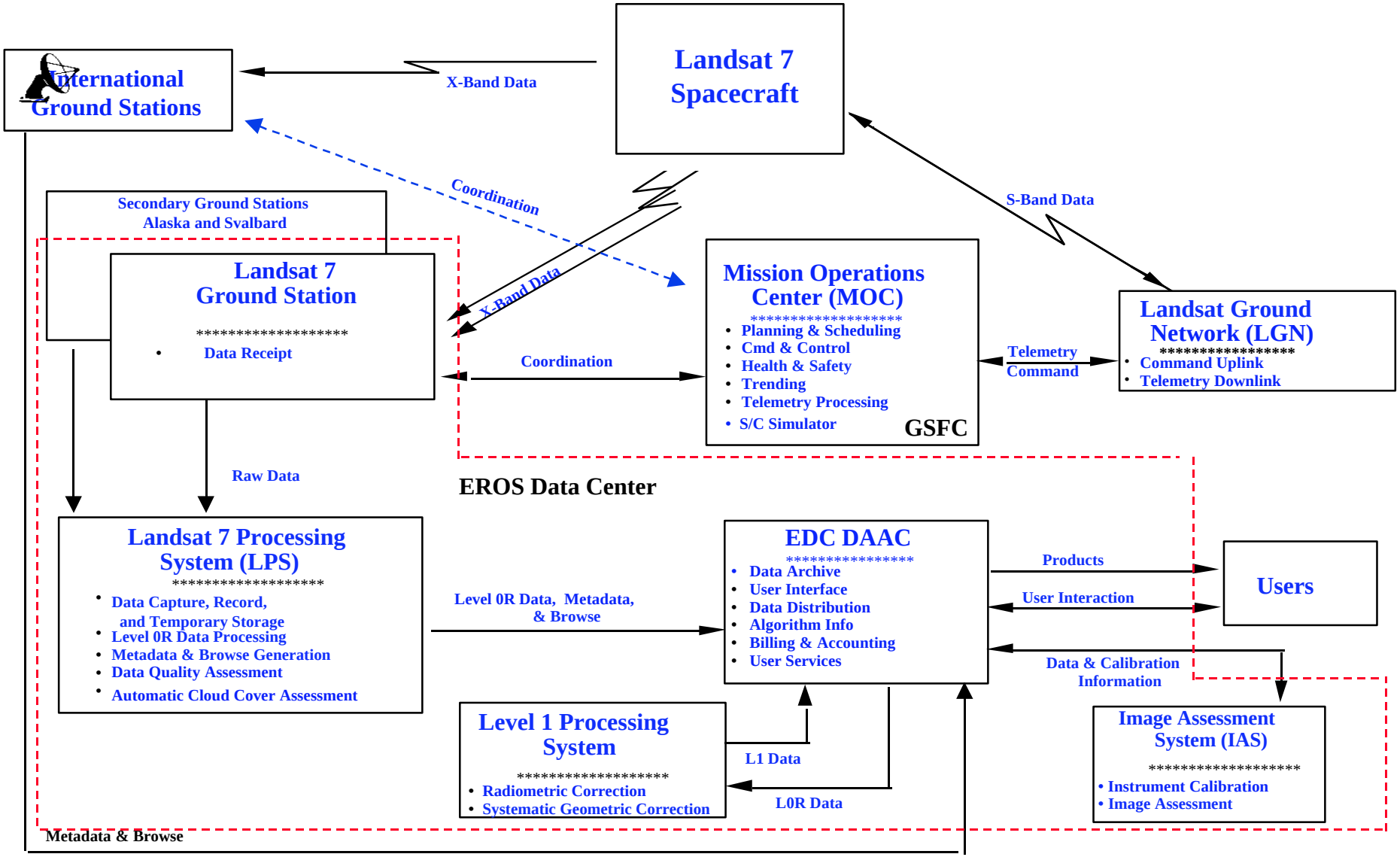
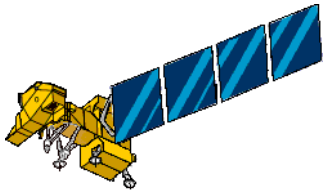


DHF QA Operations and IAS Overview

Jon Christopherson
USGS/EDC/Raytheon STX
(605)594-2563
(jonchris@edcmail.cr.usgs.gov)

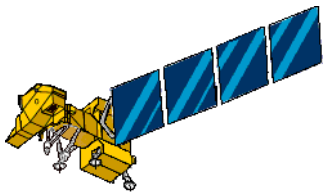
Landsat 7 Ground System





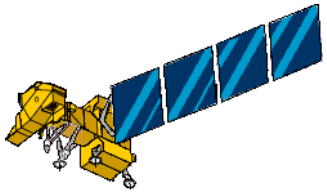
Introduction

- **L7 will bring unprecedented data volume to the DHF**
  - **250 scenes per day**
  - **At least 60% direct from L7**
  - **Up to 40% on tape from 2 polar ground stations**
- **Data volume requires new QA methods at DHF**
  - **No longer possible to screen every scene**
- **Better calibration and monitoring now possible**
  - **ETM+ capabilities for calibration**
  - **IAS designed for detailed analysis and calibration of data**



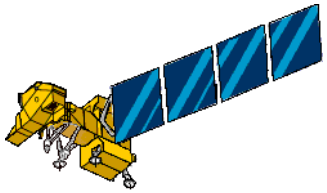
Reception and Level 0 QA Efforts

- **LPS generates large database of Level 0R results**
- **Selected results to be trended**
  - **Trends by scene, subinterval, contact period, path, row, etc.**
  - **Data includes scene quality, PCD quality, and more**
  - **Long-term Level 0 trending database maintained on IAS**
- **Running statistics will be posted in operations**
  - **Operators can detect exceptional data**
  - **“Yellow” and “Red” limits set for operator actions**
  - **Results summarized in periodic reports**
- **Operators also have Moving Window Display**
  - **Allows near real-time monitoring of processing**



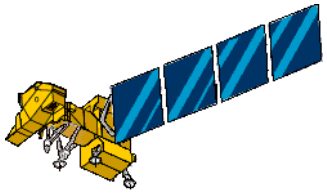
Level 1 Analysis & Calibration

- **The Image Assessment System (IAS) is the primary tool**
- **Uses Small Subset (10 scenes) of Daily Production**
- **Scenes for analysis include:**
  - **Daily Partial Aperture Calibrator (PAC) scenes**
  - **Monthly Full Aperture Calibrator (FAC) scenes**
  - **Geometric & Radiometric Ground Look Calibration scenes**
  - **One “random” scene per day**



IAS Mission & Requirements

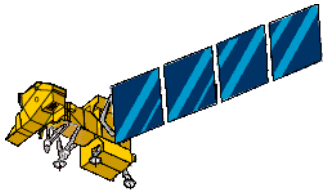
- **Radiometric Assessment and Calibration**
  - **Assessment and Artifact Removal**
  - **Internal, Solar and Ground Calibration**
- **Geometric Calibration & Assessment**
- **System Performance Evaluation**
- **Landsat 7 Calibration Parameter File**



DHF IAS Caveats

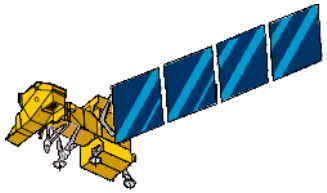
- ***Primary*** **roll of the IAS is to monitor daily Level 0 data production**
- ***Secondary*** **roll is to provide instrument calibration**
- ***Tertiary*** **roll is to aid in anomaly investigations & resolution**

- **IAS Level 1 output is *not* for general consumption**
  - **Some data will be shared with LPSO for analysis**

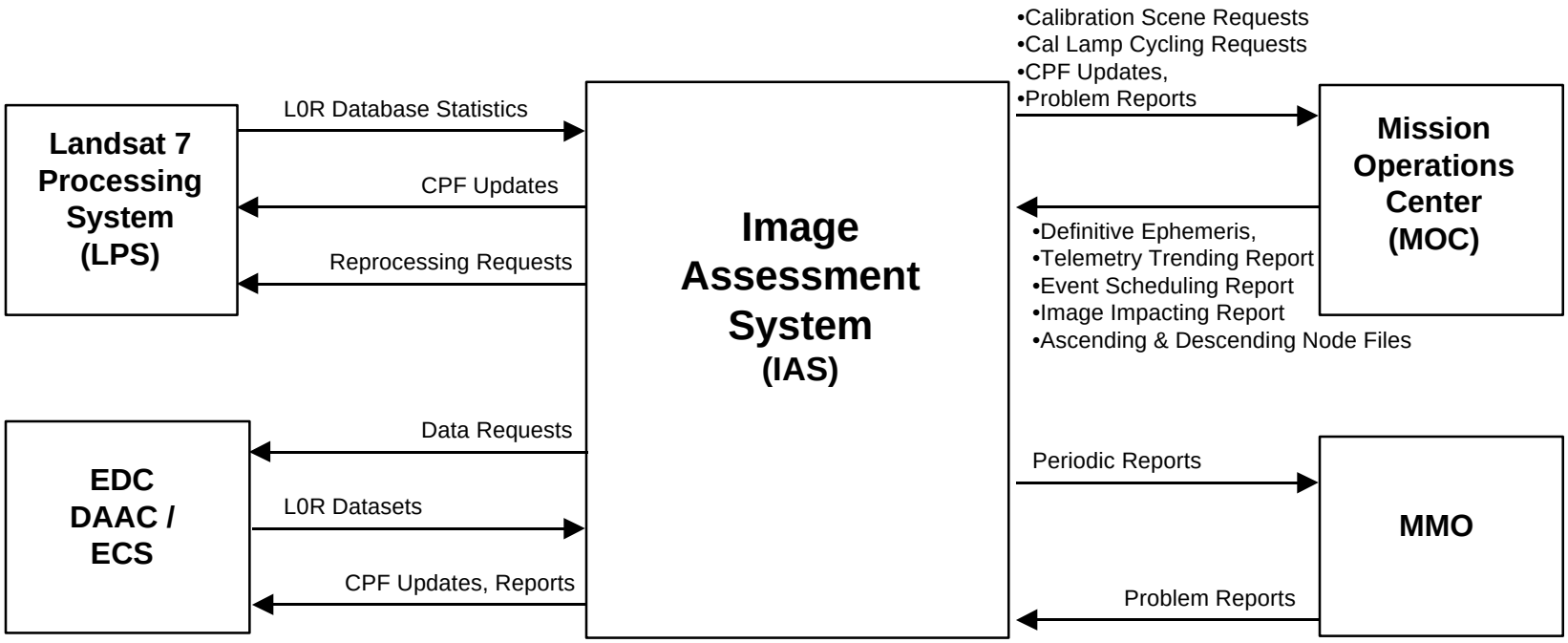


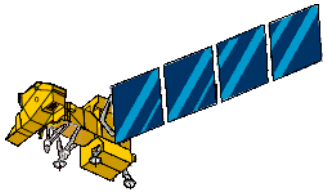
IAS Requirements

- **Ensure that high quality ETM+ Level 1 digital image products can be generated which are:**
  - **Radiometrically Corrected**
    - **detector-to-detector response equalization**
    - **calibrated to 5% uncertainty with respect to absolute at-aperture spectral radiance**
  - **Geometrically registered**
    - **band-to-band registration (0.28 pixels, 90% per axis)**
    - **geodetic accuracy (400 meters, 90% per axis)**
- **Free of artifacts, noise, blurring and geometric distortion**

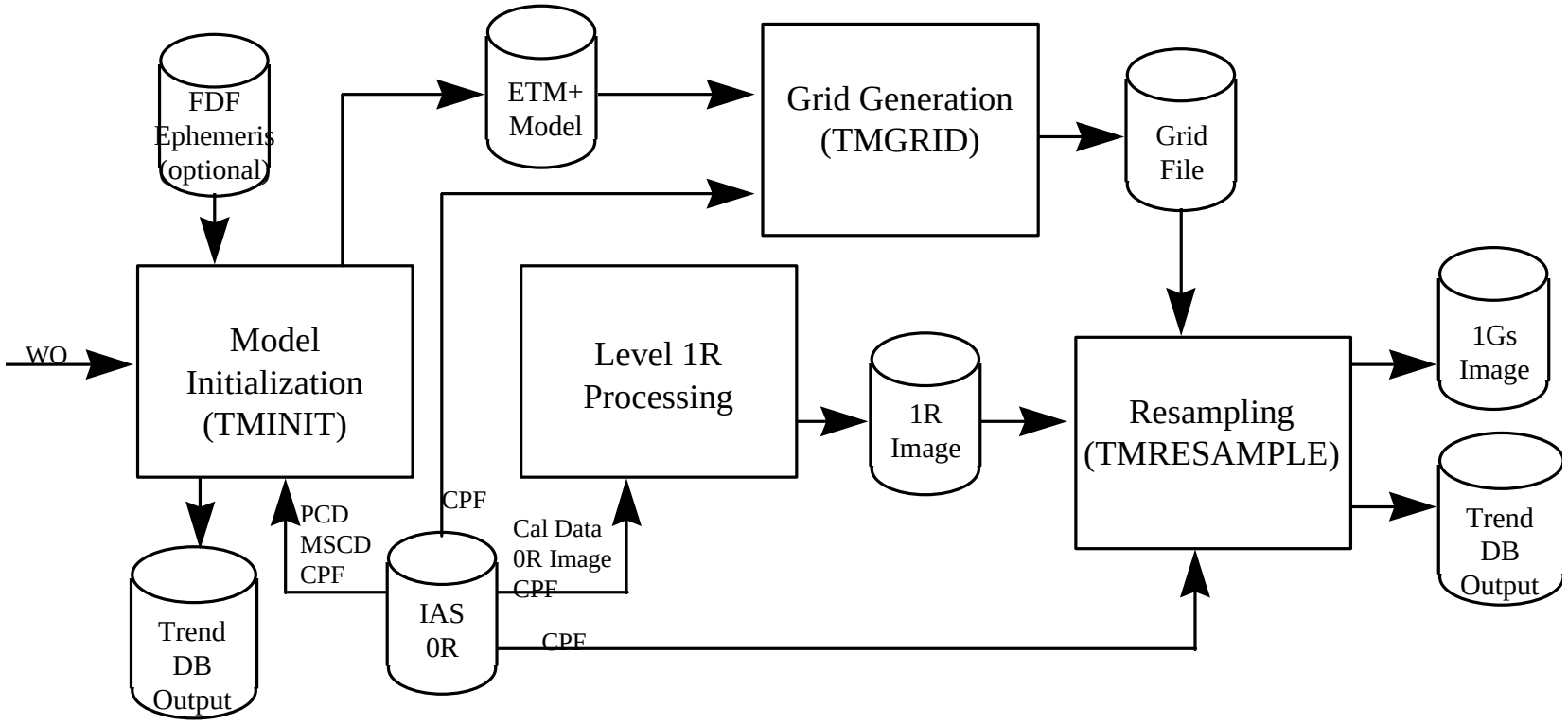


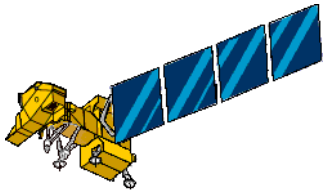
IAS Context


•Calibration Scene Requests
•Cal Lamp Cycling Requests
•CPF Updates,
•Problem Reports
Landsat 7 Processing System (LPS)
L0R Database Statistics
CPF Updates
Reprocessing Requests
Image Assessment System (IAS)
Mission Operations Center (MOC)
•Definitive Ephemeris,
•Telemetry Trending Report
•Event Scheduling Report
•Image Impacting Report
•Ascending & Descending Node Files
EDC DAAC / ECS
Data Requests
L0R Datasets
CPF Updates, Reports
Periodic Reports
Problem Reports
MMO



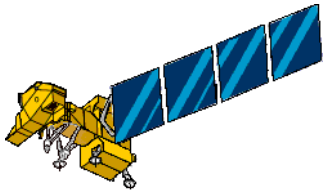
Internal IAS Functions





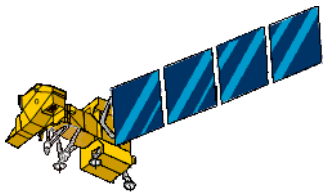
RPS Assessment

- **Characterize Data Quality**
  - **Identify and correct dropped lines**
  - **Identify and correct impulse noise**
- **Characterize Instrument Quality**
  - **Characterize and compensate for memory effect**
  - **Characterize and correct for scan correlated shift**
  - **Detect and remove coherent noise**
  - **Characterize and (optionally) compensate for system MTF**
  - **Detect and compensate for detector saturation**
  - **Detect and compensate for inoperable detectors**



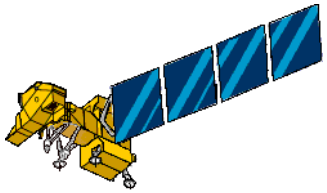
RPS Assessment (cont.)

- **Characterize Image Quality**
  - **Characterize signal to noise ratio**
  - **Detect and remove residual detector-to-detector striping**
  - **Detect and remove residual scan-to-scan banding**



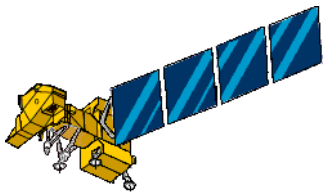
RPS Calibration

- **Internal Calibrator (IC) Calibration**
  - **Lamp and shutter data with each scene**
  - **Lamp cycling requested to monitor each lamp**
- **Partial Aperture Calibrator**
  - **Silica facets reflect solar disk to ETM+ field of view**
  - **Imaged once per day**
- **Full Aperture Calibrator**
  - **Panel reflects diffuse solar energy across full ETM+ aperture**
  - **Performed once per month**
- **Ground Look Calibration**
  - **Acquire imagery over ground test sites at least once per quarter**



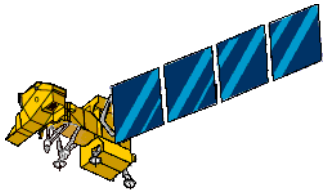
RPS Calibration (cont.)

- **Combined Radiometric Model (CRaM)**
  - **Uses results from pre-launch tests and all on-orbit calibration sources to monitor the stability and performance of each source and to determine the best calibration parameters**



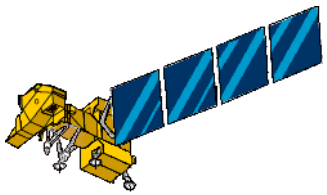
GPS Assessment

- **Band-to-Band Registration Assessment**
  - **Must be within 0.28 pixels, along and across scan (90%)**
- **Geodetic Accuracy Assessment**
  - **Systematic 1Gs product must be accurate to 400 meters along track and cross track (90%)**
- **Image-to-Image Registration Assessment**
  - **Must be able to co-register multi-temporal images to within 0.4 pixels along and cross track (90%)**
- **Geometric Accuracy Assessment**
  - **Must be free from internal distortion**



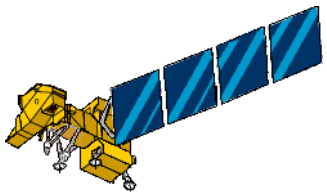
GPS Calibration

- **ETM+ Sensor to Landsat 7 Spacecraft Alignment**
  - **ETM+ line-of-sight to Landsat 7 navigation reference base alignment matrix**
- **Focal Plane Calibration**
  - **Band and detector placement**
  - **Detector delay**
- **Scan Mirror Calibration**
  - **Scan mirror profile**



IAS System Performance Evaluation

- **Monitor Long Term System Behavior/Trends**
  - **Data Quality Statistics**
  - **Instrument Quality Measures**
  - **Image Quality Measures**
  - **Radiometric Calibration Source Stability**
  - **Geometric and Geodetic Accuracy**
  - **Band-to-Band and Image-to-Image Registration**
  - **Geometric Calibration Stability**
- **Generate Periodic System Performance Reports**
  - **Available on the EDC DAAC Document Server**
- **Generate Updated Calibration Parameter Files**
  - **Provided with Level 0R products**



Calibration Parameter Files

•Detailed information in CPF used for data processing

•CPF file is roughly 1 MB in size

•Contents include:

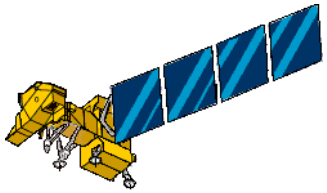
- **Geometric Parameters**
- FILE ATTRIBUTES
- EARTH CONSTANTS
- ORBIT PARAMETERS
- SCANNER_PARAMETERS
- SPACECRAFT PARAMETER
- MIRROR PARAMETERS
- SCAN_LINE_CORRECTOR
- FOCAL_PLANE_PARAMETERS
- ATTITUDE_PARAMETERS
- TIME_PARAMETERS
- TRANSFER_FUNCTION
- UT1_TIME_PARAMETERS

- **Radiometric Parameters**
- DETECTOR_STATUS
- DETECTOR_GAINS
- BIAS_LOCATIONS
- BIASES
- ACCA_THRESHOLDS
- SOLAR_SPECTRAL_IRRADIANCES
- THERMAL_CONSTANTS
- SCALING_PARAMETERS
- MTF_COMPENSATION
- GHOST_PULSE
- ME
- SCS
- STRIPING_FLAGS
- HISTOGRAM
- IMPULSE_NOISE

•COHERENT_NOISE
•DETECTOR_SATURATION
•REFERENCE_TEMPERATURES
•SENSITIVITY_TEMPERATURES
•LAMP_RADIANCE
•LAMP_REFERENCE
•REFLECTIVE_IC_COEFFS
•FASC_PARAMETERS
•B6_IC_COEFFS
•B6_VIEW_COEFFS
•B6_TEMP_MODEL_COEFFS
•THERMISTOR_COEFFS
•FILL_PATTERNS
•ENGINEERING_DATA

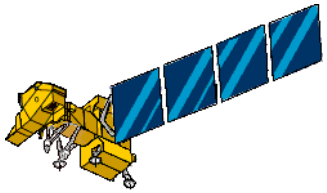
•For more information about CPF see:

- http://caster.gsfc.nasa.gov/L7/cpf.2.98.pdf



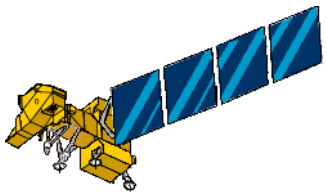
Calibration Parameter File Updates

- **Calibration Parameter File (CPF) updated every 90 days**
  - **Can be updated sooner if required**
- **Updates undergo review and approval process**
  - **approved by EDC DHF**
  - **approved by NASA L7 Project Science Office at GSFC**
- **CPFs Distributed to:**
  - **LPS**
  - **EDC DAAC**
  - **Customers (via EDC DAAC)**
  - **MOC**
  - **IGS (via MOC)**



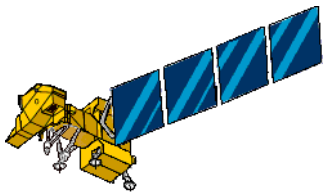
Further IAS Information

- **Further IAS information, including Radiometric and Geometric Algorithms descriptions is available on the World-Wide Web:**
  - **http://ltpwww.gsfc.nasa.gov/IAS/index.html**
- **IAS Software Available Soon**
  - **Date and method TBD**



Anomaly Resolution

- **DHF QA Department will also handle data anomalies**
- **Some anomalies detected internally**
- **Others detected outside DHF or EDC**
  - **EDC-DAAC will be focal point for customer returns, problems**
  - **Some problems resolved by DAAC, others elevated to DHF**
- **Problems found at Int'l Ground Stations referred to MMO**
  - **MMO may subsequently bring in DHF**
- **DHF may also involve LPSO, MMO, MOC, others to aid in problem resolution**
- **All anomalies recorded, tracked and reported**



Reports and Communication

- **Periodic QA reports to be published**
  - **Weekly Reports (internal, e-mail)**
  - **Monthly Reports (external, WWW)**
  - **Quarterly Reports (external, WWW) accompany CPF updates**
  - **Other reports as needed, scope and method TBD**
- **External Quality Reports to be Available via EDC DAAC**
- **Quality History to be Available on WWW**
  - **All monthly & quarterly reports**
  - **Other significant findings**